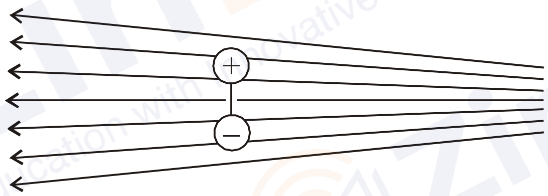
SECTION -2

PART-A

[SINGLE CORRECT CHOICE TYPE]

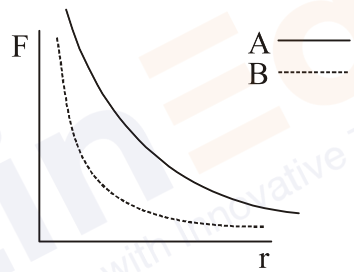
Q.1 to Q.7 has four choices (A), (B), (C), (D) out of which **ONLY ONE** is correct.

Q.1 When placed in the electric field gradient shown below, the dipole is subjected



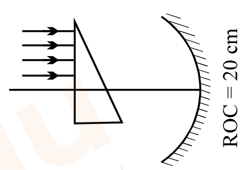
(A) a clockwise torque and a net linear acceleration
(B) a counterclockwise torque and a net linear acceleration
(C) a clockwise torque and no net linear acceleration
(D) a counterclockwise torque and no net linear acceleration

Q.2 There are two protons each at the same distance from two different uniformly charged spheres A and B. The force experinced by the proton is given in the graph for the two different cases.



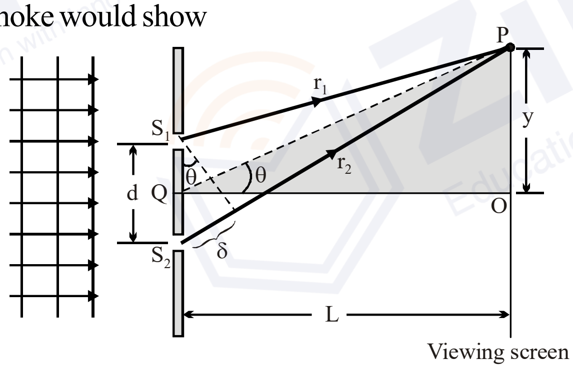
(A) A has more positive charges than B. (B) B has more positive charges than A.
(C) A has a larger radius than B. (D) B has a larger radius than A.

Q.3 A parallel beam of light is incident on the upper part of a prism of angle 2° and R.I. 3/2. The light coming out of the prism falls on a concave mirror of radius of curvature 20 cm. The distance of the point (where the rays are focused after reflection from the mirror) from the principal axis is :



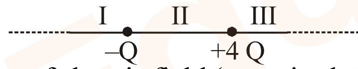
(A) 0.175 cm (B) 8 cm (C) 0.314 cm (D) None of these

Q.4 If you were to blow smoke into the space between the barrier of standard YDSE and the viewing screen of figure, the smoke would show



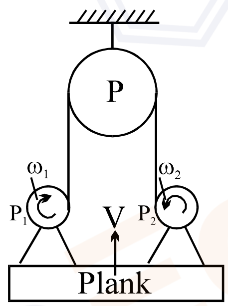
(A) Fringes are real and localized
(B) Fringe are virtual and non localized
(C) Fringes are real and non-localized
(D) Fringes are virtual and localized.

Q.5 The figure shows, two point charges $q_1 = +4Q$ (>0) and $q_2 = -Q$. The charges divide the line joining them in three parts I, II and III



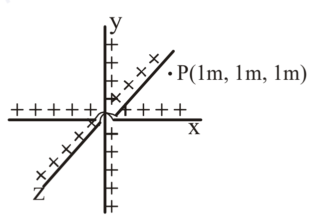
(A) Region III has a local maxima of electric field (magnitude wise)
(B) Region I has a local minima of electric field (magnitude wise)
(C) Equilibrium position for a test charge lies in region II
(D) Region I has a local maxima of electric field (magnitude wise)

Q.6 In the figure shown two motors P_1 & P_2 fixed on a plank which is hanging with light string passing over fixed Pulley P. If the motors starts winding the thread with angular velocity ω_1 & ω_2 then velocity of plank V is (here R_1 & R_2 are the radii of motor rotor respectively)
[Given : $\omega_1 = 2$ rad/s, $R_1 = 2$ m, $\omega_2 = 2$ rad/s, $R_2 = 3$ m]



(A) 20 m/s
(B) 10 m/s
(C) 5 m/s
(D) 4 m/s

Q.7 Three infinitely long uniformly charged (linear charge density = λ) thin wire are placed along x, y & z axis, then find the electric field strength at point P (1 m, 1 m, 1m).



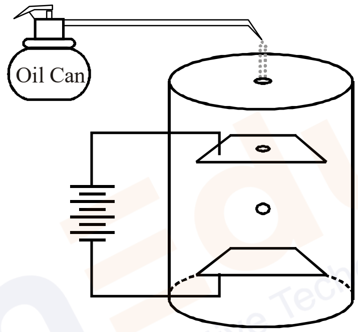
(A) $\frac{\lambda}{2\pi \in_0}\sqrt{3}$
(B) $\frac{\lambda}{4\pi \in_0}\sqrt{3}$
(C) $\frac{\lambda}{8\pi \in_0}\sqrt{3}$
(D) $\frac{2\lambda}{\pi \in_0}\sqrt{3}$

[PARAGRAPH TYPE]

Q.8 to Q.11 has four choices (A), (B), (C), (D) out of which **ONLY ONE** is correct.

Paragraph for question nos. 8 to 9

In 1906, Robert Millikan devised an experiment that allowed him to determine the charge of an electron. A schematic of Millikan's set-up is shown below :



Two metal plates are connected by a series of batteries to form a capacitor. There is an electric field between the plates. The metal plates are inside an insulated cylindrical container.

Oil drops are introduced into the container through a small hole in the top. The oil drops acquire a negative charge as they pass through the nozzle of the oil can. Some of the drops fall through a hole in the upper plate. By adjusting the voltage between the plates, certain drops can be suspended between them. The relationship between the electric field between the plates and the voltage across the plates is :

$\Delta V = EL$

where E is the electric field and L is the plate separation.

Millikan chose oil because of its relatively low vapor pressure and high charge-holding ability.

Q.8 In order for an oil drop of mass m, radius r, and charge density ρ, to be suspended between the plates, the magnitude and direction of the electric field must be :

(A) $\frac{3mg}{4\pi r^3\rho}$; downward
(B) $\frac{4\pi r^3\rho}{3mg}$; downward
(C) $\frac{3mg}{4\pi r^3\rho}$; upward
(D) $\frac{4\pi r^3\rho}{3mg}$; upward

Q.9 Suppose the original oil droplet were replaced with a positively charged one that had twice the charge and three times the mass of the original droplet. How would the magnitude of the electric field have to be changed in order for the drop to remain suspended ?

(A) No change is necessary
(B) It must be increased by a factor of 2
(C) It must be decreased by a factor of 2/3
(D) It must be increased by a factor of 3/2

Paragraph for question nos. 10 to 11

Snow skiing is one of the more popular winter sports. People who ski tend to be either downhill skiers or cross-country skiers. In downhill skiing, skiers are taken to the top of the mountain by means of a lift chair, although some ski resorts still use tow ropes. With tow ropes, the skier grabs on to the tow rope and is pulled up the mountain (figure-1). Once at the top of the mountain, the idea is for the skier to get back down, and enjoy the ride while doing it ! Inexperienced skiers tend to ski straight down the mountain ; their motion is much like that of a block sliding down an inclined plane (figure-2). Experienced skiers know how to control their rate of descent by making a series of S-shaped turns as they come down the ski run.

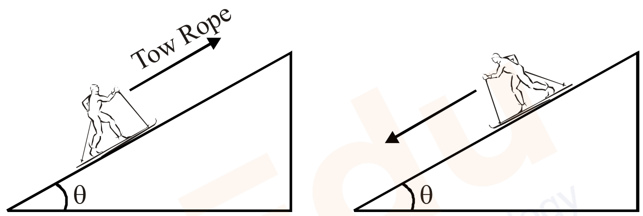


Figure-1 Figure-2

Cross-country skiing is quite different from downhill skiing. Essentially, specially designed skis allow the skier to "walk" across the snow. The base of the ski is coated with a surface that glides easily in the forward direction. This action is different from just strapping on snowshoes, however. Cross-country skis allow the skier to bend his leg at the ankle. Ideally, the skis should just glide across the snow.

Q.10 Occasionally, a skier has to "side step" up a hill. She does this by turning her skis perpendicular to the hill, and then she makes series of small steps up the hill. This enables her to climb the hill. The maximum steepness of a hill that a skier can side step is determined by :
I. The weight of the skier.
II. The coefficient of static friction between the skis and the snow.
III. The coefficient of kinetic friction between the skies and the snow.
IV. The initial velocity of the skier.
(A) I only (B) I and III only (C) II, III and IV (D) II only

Q.11 Suppose a skier falls and begins sliding down the hill shaped as shown in figure. Her speed at the bottom of the hill depends on :
I. Her weight
II. Her speed at the time of the fall.
III. Length of the hill.
IV. The steepness of the hill.
(A) I only (B) III only (C) I, II and III (D) II, III and IV

[MULTIPLE CORRECT CHOICE TYPE]

Q.12 to Q.15 has four choices (A), (B), (C), (D) out of which **ONE OR MORE** may be correct.

Q.12 Positive charge Q is distributed uniformly throughout an insulating sphere of radius R, centered at the origin. A particle with positive charge Q is placed at x = 2R on the x axis.

(A) The potential at $x = \frac{R}{2}$ is $\frac{49Q}{96\pi R \epsilon_0}$ (B) The electric field at $x = \frac{R}{2}$ is $\frac{Q}{72\pi \epsilon_0 R^2}$

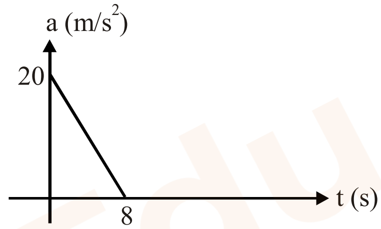
(C) Electric field at $x = \frac{R}{2}$ is $\frac{17Q}{72\pi \epsilon_0 R^2}$ (D) Electric potential at $x = \frac{R}{2}$ is $\frac{3Q}{2\pi \epsilon_0 R}$

Q.13 Assume that entire xz-plane is charged with a uniform surface charge density of 8.85×10^{-12} C/m^2. The potential at origin is assumed to be 0. (Take : $\epsilon_0 = 8.85 \times 10^{-12}$ C^2/m^{2}N)
(A) potential at (2,–2, –2) is –1V (B) potential at (–2,–2, –2) is –1V
(C) potential at (2,0, 2) is 4V (D) potential at (2,–2, –2) is 1V

Q.14 White light is incident normally on a film which has μ = 1.5 and thickness of 5000 Å. The wavelengths in visible spectrum (4000 Å-7000 Å) for which intensity of reflected light be maximum is

(A) 5000 Å (B) $\frac{30000}{7}$ Å (C) $\frac{10000}{3}$ Å (D) 6000 Å

Q.15 The acceleration time graph of a particle is given as follows :



Initial velocity of particle is 10 m/s. (Answer the following question for the time interval from t = 0 to t = 8 sec.). Mark the correct option(s).

(A) the displacement of the particle, at the end of 8 sec. is 1520/3

(B) minimum velocity of particle is at t = 8 sec

(C) maximum velocity is 90 m/s

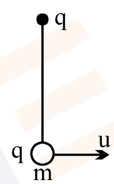
(D) velocity of particle cannot be zero

PART-C

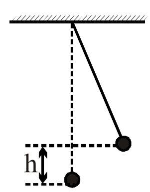
[INTEGER TYPE]

Q.1 to Q.5 are "Integer Type" questions. (The answer to each of the questions **are upto 4 digits**) **[5 Marks]**

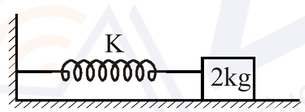
Q.1 The bob of a pendulum has mass m = 10 kg and charge q = +80 μC. Length of pendulum is l = 0.4 m. The point of suspension also has the same charge +80 μC. What the minimum speed 'u' (in m/s) should be imparted to the bob so that it can complete vertical circle?



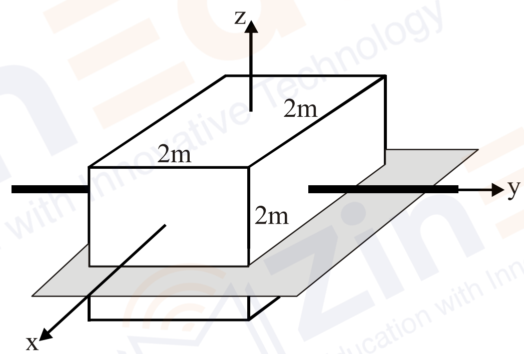
Q.2 A small positively charged ball of mass 'm' is suspended by an insulating thread of negligible mass. Another positively charged small ball is moved very slowly from a large distance until it is in the original position of first ball. As a result ball rises by 'h'. The work that has been done is kmgh. The value of k is ___



Q.3 When displaced and released, the 2kg mass oscillates on a frictionless horizontal surface with a period of $\frac{\pi}{6}$ seconds. A small mass (negligible compared to 2 kg) is placed on 2 kg block. The co-efficient of static friction between the small mass and 2kg block is μ = 0.1. The maximum amplitude of oscillation before the small mass slips is _____ × 10^{-3} m. (Round off to nearest integer)



Q.4 Charge in the form of a plane sheet with density $\sigma = 40\ \mu C/m^2$ is located at $z = -0.5$ m. A uniform line of charge of density $\lambda = -6\ \mu C/m$ lies along the y-axis. Net flux that crosses the surface of cube 2m on an edge, centered at the origin as shown, is ______ $\frac{10^{-6}}{\epsilon_0}\frac{N}{C}m^2$



Q.5 It was once suggested that the mirror for an astronomical telescope could be produced by rotating a partially filled cylinder of mercury at a prescribed angular velocity $\sqrt{50}$ rad/sec, about a vertical axis. Velocity of object moving along vertical axis at 30 cm from mirror is 4 m/s. Velocity of image (in m/s) at that instant is